WHAT IS CLAIMED IS:

1. A system for generating electrical power for supply to a load, comprising:

an air-breathing engine mechanically communicating with a movable shaft, the engine being structured and arranged to receive a mixture of air and fuel and burn the mixture such that the mixture expands and creates mechanical power that is used to drive the shaft;

a fuel system coupled with the engine and operable to supply fuel to the engine, the fuel system being responsive to a fuel control signal to vary a rate of fuel flow to the engine;

at least one engine sensor operable to measure at least one thermodynamic variable associated with the engine that is indicative of a relative thermodynamic efficiency of the engine;

an electrical generator coupled to the shaft such that movement of the shaft by the engine causes the generator to operate to create an alternating electrical current, the engine, shaft, and generator being connected such that a change in speed of the generator causes a corresponding change in speed of the engine and hence a change in rate of air flow through the engine;

a power electronics unit coupled to the generator for receiving the alternating electrical current therefrom and operable to synthesize an alternating output current and voltage at a predetermined frequency and relative phase for supply to the load;

a generator power sensor operable to measure power output from generator;

a load power sensor operable to measure power demanded by the load; and

a controller operably connected to the fuel system, to the at least one engine sensor, to the power electronics unit, to the generator power sensor, and to the load power sensor, the controller being operable to control the fuel system so as to cause the power output from the system to substantially match the power demanded by the load, and simultaneously to electrically control the generator to regulate speed thereof so as to control air flow rate through the engine in such a manner that fuel/air ratio of the mixture burned in the engine is controlled to substantially maximize the relative thermodynamic efficiency of the engine.

2. The system of claim 1, wherein the power electronics unit comprises an AC/DC module structured and arranged to operate upon the alternating electrical current from the generator so as to produce a non-alternating direct current at a non-alternating voltage, and a DC/AC module structured and arranged to operate upon the non-alternating direct current so as to synthesize the alternating output current that is supplied to the load, the AC/DC module being responsive to a current control signal to vary the level of the non-alternating direct current independently of the alternating electrical current from the generator, the control system being operable to supply the current control signal to the AC/DC module to control the level of the direct current output by the AC/DC module and thereby control generator speed.

3. The system of claim 1, wherein the generator and shaft are rotationally movable.

4. The system of claim 3, wherein the engine comprises a compression device operable to compress air and a power device that receives the compressed air from the compression device and the fuel from the fuel system and burns the air and fuel mixture to produce mechanical power.

5. The system of claim 4, further comprising a heat exchanger arranged to receive the compressed air from the compression device and exhaust gases from the power device, the heat exchanger causing heat transfer from the exhaust gases to the compressed air so as to pre-heat the compressed air prior to combustion in the power device.

6. The system of claim 5, wherein the power device includes a combustor in which the air and fuel mixture is burned to produce hot gases, and an expansion device for expanding the hot gases so as to produce the mechanical power.

7. The system of claim 6, wherein the expansion device comprises a turbine.

8. The system of claim 7, wherein the turbine is a fixed-geometry turbine.

9. The system of claim 6, wherein the compression device is a fixed-geometry compressor.

10. The system of claim 6, wherein the combustor is a fixed-geometry combustor.

11. The system of claim 6, wherein the combustor comprises a catalytic combustor.

12. The system of claim 11, further comprising a sensor operable to measure a variable indicative of combustor inlet temperature, and wherein the controller is connected to said sensor and is operable to control air flow through the engine in such a manner as to maintain the combustor inlet temperature above a predetermined minimum temperature required for catalytic operation.

13. The system of claim 12, further comprising a sensor associated with the heat exchanger operable to measure a variable indicative of a temperature of the exhaust gases entering the heat exchanger, and wherein the controller is connected to said sensor associated with the heat exchanger and is operable to control air flow through the engine to maintain the temperature of the exhaust gases entering the heat exchanger below a predetermined maximum temperature.

14. The system of claim 1, wherein the generator is a wound generator.

15. The system of claim 14, further comprising an excitation system operable to excite the generator.

16. The system of claim 15, wherein the control system is operable to control the excitation system so as to electrically control the generator speed and thereby control air flow rate.

17. A method for controlling an electrical generator system having an air-breathing engine mechanically communicating with a movable shaft, the engine being structured and arranged to receive a mixture of air and fuel and burn the mixture such that the mixture expands and creates mechanical power that is used to drive the shaft, the system having a fuel system coupled with the engine and operable to supply fuel to the engine, the fuel system being responsive to a fuel control signal to vary a rate of fuel flow

to the engine, the system having an electrical generator coupled to the shaft such that movement of the shaft by the engine causes the generator to operate to create an alternating electrical current, wherein the engine, shaft, and generator are connected such that a change in speed of the generator causes a corresponding change in speed of the engine and hence a change in rate of air flow through the engine, and the system having a power electronics unit coupled to the generator for receiving the alternating electrical current therefrom and operable to synthesize an alternating output current and voltage at a predetermined frequency and relative phase for supply to the load, wherein electrical power output from the system is substantially determined by fuel flow rate to the engine, the method comprising the steps of:

determining a power demanded by the load;

measuring at least one thermodynamic variable associated with the engine that is indicative of a relative thermodynamic efficiency of the engine;

controlling the fuel supply system to supply fuel to the engine at a controlled fuel flow rate such that the electrical power output from the system substantially matches the power demanded by the load; and

controlling the air flow rate through the engine independently of the electrical power output from the system so as to control fuel/air ratio of the mixture burned in the engine in such a manner as to substantially optimize the thermodynamic efficiency of the engine while substantially matching the power demanded by the load, the air flow rate being controlled by electrically controlling the speed of the generator and hence the air flow rate through the engine.

18. The method of claim 17, wherein the alternating electrical current from the generator is converted in an AC/DC module into a non-alternating direct current at a non-alternating voltage, and the non-alternating direct current from the AC/DC module is converted in a DC/AC module to synthesize the alternating output current that is supplied to the load, the AC/DC module being responsive to a current control signal to vary the level of the non-alternating direct current independently of the alternating electrical current from the generator, and wherein the step of controlling the air flow rate comprises actively controlling the non-alternating direct current from the AC/DC module of the power electronics unit so as to alter the speed of the generator and hence the air flow rate.

19. A method for controlling an electrical generator system having an air-breathing engine mechanically communicating with a movable shaft, the engine being structured and arranged to receive a mixture of air and fuel and burn the mixture such that the mixture expands and creates mechanical power that is used to drive the shaft, the system having a fuel system coupled with the engine and operable to supply fuel to the engine, the fuel system being responsive to a fuel control signal to vary a rate of fuel flow to the engine, the system having an electrical generator coupled to the shaft such that movement of the shaft by the engine causes the generator to operate to create an alternating electrical current, wherein the engine, shaft, and generator are connected such that a change in speed of the generator causes a corresponding change in speed of the engine and hence a change in rate of air flow through the engine, and wherein electrical power output from the system is substantially determined by fuel flow rate to the engine, the method comprising the steps of:

determining a power demanded by the load;

measuring at least one thermodynamic variable associated with the engine that is indicative of a relative thermodynamic efficiency of the engine;

controlling the fuel supply system to supply fuel to the engine at a controlled fuel flow rate such that the electrical power output from the system substantially matches the power demanded by the load;

operating upon the alternating electrical current from the generator so as to produce a non-alternating direct current at a non-alternating voltage;

operating upon the non-alternating direct current so as to synthesize an alternating output current and voltage at a predetermined frequency and relative phase for supply to the load;

controlling the air flow rate through the engine independently of the electrical power output from the system so as to control fuel/air ratio of the mixture burned in the engine in such a manner as to substantially optimize the thermodynamic efficiency of the engine while substantially matching the power demanded by the load, the air flow rate being controlled by actively controlling the non-alternating direct current so as to alter the speed of the generator and hence the air flow rate through the engine.

20. The method of claim 19, wherein optimizing the thermodynamic efficiency of the engine comprises causing a peak temperature of a thermodynamic cycle of the engine to substantially match a predetermined value.

21. The method of claim 19, wherein the engine comprises a turbine engine having a compressor for compressing the air, a combustor for burning the mixture of air and fuel to produce hot gases, and a turbine for expanding the hot gases, and wherein optimizing the thermodynamic efficiency of the engine comprises causing a turbine inlet temperature to substantially match a predetermined value.

22. The method of claim 21, wherein the combustor comprises a catalytic combustor, and further comprising the steps of:

measuring a variable indicative of an inlet temperature to the combustor; and

controlling air flow through the engine in such a manner as to maintain the combustor inlet temperature above a predetermined minimum temperature required for catalytic operation.

23. A method for improving part-load efficiency of an air-breathing engine in an electrical generator system, the system having a movable shaft mechanically communicating with the engine and a fuel system coupled with the engine and operable to supply fuel to the engine at a controlled fuel flow rate, the engine being designed such that peak thermodynamic efficiency of the engine substantially coincides with a design point operating condition of the engine, the system having an electrical generator coupled to the shaft such that movement of the shaft by the engine causes the generator to operate to create an alternating electrical current, wherein the engine, shaft, and generator are connected such that a change in speed of the generator causes a corresponding change in speed of the engine and hence a change in rate of air flow through the engine, and wherein electrical power output from the system is substantially determined by fuel flow rate to the engine, the method comprising the steps of:

operating the engine at a first part-load condition; and

at said first part-load condition, controlling the speed of the generator so as to control air flow rate through the engine while simultaneously controlling fuel flow rate to

the engine so as to control fuel/air ratio in such a manner that a peak cycle temperature of the engine is substantially the same as the peak cycle temperature corresponding to the design point operating condition.

24. The method of claim 23, further comprising the step of controlling the fuel flow rate so that electrical power output from the system substantially matches a power demand of the load at said part-load condition.

25. The method of claim 23, wherein the step of controlling the speed of the generator comprises controlling an electrical current level downstream of the generator.

26. The method of claim 25, wherein the alternating current from the generator is converted into a direct current and then the direct current is converted into an alternating current at a fixed frequency independent of the speed of the generator for supply to a load, and wherein the step of controlling the electrical current level comprises controlling the level of the direct current.

27. The method of claim 23, further comprising the steps of:

using a recuperator to pre-heat air being supplied to the engine for mixing with the fuel, the recuperator causing heat exchange between the air and exhaust gases discharged from the engine;

operating the engine at a second part-load condition that is lower in load than said first part-load condition; and

at said second part-load condition, controlling the speed of the generator so as to control air flow rate through the engine while simultaneously controlling fuel flow rate to the engine so as to control fuel/air ratio in such a manner that the peak cycle temperature is allowed to fall below the peak cycle temperature corresponding to the design point operating condition so that the temperature of the exhaust gases entering the recuperator does not exceed a predetermined maximum allowable value.

28. The method of claim 23, wherein the fuel is combusted in a catalytic combustor having a predetermined minimum inlet temperature required for maintenance of a catalytic reaction in the combustor, and wherein the fuel/air ratio is controlled in

such a manner at said first part-load condition that an inlet temperature to the combustor is at least as great as said predetermined minimum inlet temperature.

29. The method of claim 28, wherein the fuel/air ratio is controlled in such a manner that the inlet temperature to the combustor at said first part-load condition is greater than the inlet temperature to the combustor at said design point operating condition.